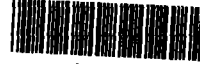


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226796

10/3/02
J.A.**FACSIMILE TRANSMISSION****Date:** October 3, 2002**To:** Fred Micke/Verneta Simon USEPA 312-353-9176

David Carlins/Kara Hughes Lakeshore East Development 312-642-2773

Fax No.: ~~226796~~**Pages being transmitted, incl. Cover:** 24**CC:** **Fax No.:****From:** Rich Berggreen **Phone:** 847-279-2500**Re:**☐ Urgent ☐ For Signature ☐ For Review ☐ Please Comment/Reply ☐ As Requested ☐ Original to Follow**Message:**

Attached is SOP-366 and SOP-372 which was inadvertently left out of the Lakeshore East Work Plan. Three copies will be sent to you to be included in the binders your received. If you have any questions, please contact me.

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LAKESHORE EAST

STANDARD OPERATING PROCEDURE

Title: Operation of the ACCUSPEC Gamma Counter

Document: SOP-366

Revision Number: 0

Date: June 19, 2002

Replaces: New

OPERATION OF THE ACCUSPEC GAMMA COUNTER

1.0 SCOPE

1.1 Purpose

This procedure describes the step for performing gamma spectral analysis of samples utilizing the Accuspec Gamma Spectroscopy system.

1.2 Applicability

This procedure applies to the analysis of samples utilizing the Accuspec Gamma Spectroscopy system.

2.0 REFERENCES

- 32 Illinois Administrative Code, Parts 310 and 340, Standards for Protection from Radiation
- 32 Illinois Administrative Code, Part 400, Notices Instructions and Reports to Workers; Inspections
- ACCUSPEC Instaliation and Uses Guide, CANBERRA Program Documentation Version 03 March 1990
- RADIOACTIVE DECAY DATA TABLES, D. C. Kocher
- NaI(Tl) DETECTORS MODEL 802 SERIES, CANBERRA Operator's Manual
- PHOTOMULTIPLIER TUBE BASE/PREAMPLIFIER MODEL 2007P CANBERRA Operator's Manual
- USNRC Regulatory Guide 4.14

3.0 DEFINITIONS

None.

4.0 REQUIREMENTS

4.1 Prerequisites

4.1.1 The Accuspec system is operational

4.1.2 Samples to be analyzed by the Accuspec system must be in the 20 ml liquid scintillation vial geometry.

4.2 Tools, Material, Equipment

4.2.1 Canberra NaI(Tl) detector model 802

4.2.2 Canberra photomultiplier tube base/preamplifier model 2007P

4.2.3 Accuspec gamma spectroscopy program

4.3 Precautions, Limits

- 4.3.1 Use only plastic liquid scintillation vials 16.7 to 28 mm in diameter.
- 4.3.2 Power is to remain applied to this equipment. Should power be lost a warm up time of 24 hours may be required upon restart.
- 4.3.3 Ensure all samples to be analyzed are free from external contamination.

4.4 Acceptance Criteria

- 4.4.1 Background and Efficiency checks shall be performed daily prior to use.

NUTRANL gamma pulse height analysis software does not employ "target energies" to identify and quantify nuclides. All gamma photopeaks over the range of interest are used. The Packard AccuSpec Gamma Counter system is adjusted to monitor the energy range from 50 to 2,000 keV, inclusive.

The Minimum Detectable Activity (MDA) is as follows:

Counting Time	U-238 pCi/g	Ra-226 pCi/g	Ra-228 pCi/g	K-40 pCi/g
	4.6	1.4	1.3	32

MDA elated in compliance with USNRC Regulatory Guide 4.14 (at 4.65 times the standard deviation of the analysis for the instrument background).

- 4.4.2 All efficiency checks shall be within 2 standard deviations from the certified activity of the standard measured.
- 4.4.3 All samples to be analyzed shall be preceded by analysis of the Uranium, Thorium, Radium, Potassium, and Blank standards.

The calibration standards contain U-238 (in secular equilibrium through U-234), Th-232 (in secular equilibrium with progeny), Ra-226 (in secular equilibrium through Po-214), pCi/g K-40. The density of each standard is similar to that of lightly compacted soil (1.5 g/cc). The U-238, Th-232 and Ra-226 standards are traceable to NIST. The K-40 standard is not NIST traceable. The blank is chromatographic grade alumina.

- 4.4.4 The Canberra system measures and records elapsed time, live time and dead time. The NUTRANL code uses the live time. System dead time is typically 9 to 0% for samples ranging from background up to 1,000 pCi/g Ra.

5.0 PROCEDURE

5.1 Initial Instrumentation Setup

- 5.1.1 Connect the equipment cables in accordance with the manufactures technical manual.
- 5.1.2 From the C:> prompt type "START" and press enter to start NUTRANL.
- 5.1.3 Enter "SETUP" for the category.
- 5.1.4 Enter "YYMMDDS1" for the sample ID.
- 5.1.5 Enter "SYSTEM SETUP" for the description.

- 5.1.6 Press the "ESC" key.
- 5.1.7 Open the detector shield assembly, place the 20 gram Thorium Standard in the detector, and close the detector shield assembly.
- 5.1.8 Select "S" to open the SETUP menu.
- 5.1.9 Select "V" to open the HVPS menu.
- 5.1.10 Select "L" to open the VOLTAGE LEVEL menu.
- 5.1.11 Enter "1000" to set the high voltage to 1000 volts.
- 5.1.12 Select "N" to turn the high voltage on.
- 5.1.13 Press the "ESC" key to return to the SETUP menu.
- 5.1.14 Select "A" to open the ADC menu.
- 5.1.15 Select "G" to open the CONV.GAIN menu.
- 5.1.16 Select "2" to set the conv. gain to 2048.
- 5.1.17 Press "ESC" key to return to the ADC menu.
- 5.1.18 Select "U" to set the ULD, normally set to 100%.
- 5.1.19 Set the ULD level using the left and right arrow keys and press "ENTER" to lock the setting.
- 5.1.20 Press "ESC" to return to the ADC menu.
- 5.1.21 Set the desired LLD level using the COARSE LLD and the FINE LLD menus.
- 5.1.22 Press "SHIFT-F2" to erase the current spectrum.
- 5.1.23 Press "F1" to start acquisition.
- 5.1.24 Collect a spectrum that will determine the channel location of the 74 KeV peak from Thorium.
- 5.1.25 Adjust the ADC ZERO to place the 74 KeV peak in channel 74.
- 5.1.26 Repeat steps 5.1.23 to 5.1.25 to adjust the ADC ZERO.
- 5.1.27 Open the detector shield assembly, remove the Thorium standard, place a Cs-137 source in the detector, and close the detector shield assembly.
- 5.1.28 Press "SHIFT-F2" to erase the current spectrum.
- 5.1.29 Press "F1" to start acquisition.
- 5.1.30 Collect a spectrum that will determine the channel location of the 662 KeV peak from Cs-137.
- 5.1.31 Adjust the AMP GAIN to place the 662 KeV peak in channel 662.

5.1.32 Repeat steps 5.1.27 to 5.1.30 to adjust the AMP GAIN

5.1.33 Repeat steps 5.1.23 to 5.1.30 to until both the 74 KeV and the 662 KeV peaks are in the proper channels.

5.1.34 Record the ADC, AMP, and HVPS settings in the Accuspec Log Book.

5.2 NUTRANL CALIBRATION

5.2.1 From the C:> prompt type "START" and press enter to start NUTRANL.

5.2.2 Enter "CALIB URANIUM" for the Category.

5.2.3 Enter "YMMDDC1" for the sample ID.

5.2.4 Enter "URANIUM STANDARD" for the description.

5.2.5 Enter 20.0 for the weight of the sample.

5.2.6 Press the "ESC" key.

5.2.7 Open the shield assembly, place a Cs-137 source in the detector, and close the shield assembly.

5.2.8 Press "SHIFT-F2" to erase the current spectrum.

5.2.9 Press "F1" to start acquisition.

5.2.10 Collect at least a two minute spectrum and press "F1" to stop acquisition.

5.2.11 Record the ADC, AMP, and HVPS settings in the Accuspec Log Book.

5.2.12 Adjust the AMP gain settings, if necessary, to align the Cs-137 662 KeV peak in the 662 channel and record any changes in the Accuspec Log Book.

5.2.13 Open the detector shield assembly, remove the Cs-137 source and place the 20 gram Uranium standard in the detector well and close the detector shield assembly.

5.2.14 Select "A" to open the acquire menu.

5.2.15 Select "P" to open the preset time menu.

5.2.16 Select "L" to open the preset live time menu.

5.2.17 Enter 16 minutes and 40 seconds, 1000 seconds, for the preset live time.

5.2.18 Press the "ESC" key until the main menu is reached.

5.2.19 Press "SHIFT-F2" to erase the current spectrum.

5.2.20 Press "F1" to start acquisition.

5.2.21 Upon completion of acquisition press "M" to open the move menu.

5.2.22 Select "D" to open the data menu

- 5.2.23 Press "ENTER" to use the default file to transfer the spectrum from.
- 5.2.24 Enter "F" to name the file to transfer the spectrum and press "enter".
- 5.2.25 Press "ENTER" to use the default Header.
- 5.2.26 Press "ENTER" to use the default Eff File.
- 5.2.27 Press the "ESC" key to return to the main menu..
- 5.2.28 Press "E" to exit the program.
- 5.2.29 Enter a "Y" to continue exiting.
- 5.2.30 When prompted to continue analysis enter a "Y" to perform NUTRANL analysis. The U-238 standard should yield approximately 127,200 counts in 1,000 sec of live time counting. The counter is being calibrated against all photopeaks in the spectrum over the energy range from approximately 50 to 2,000 keV.
- 5.2.31 The computer will display "U-238 IS DONE. PLEASE START THE TH-232 STANDARD. PRESS ANY KEY"
- 5.2.32 Press "ENTER" to continue.
- 5.2.33 Enter "YMMDDC2" for the sample ID.
- 5.2.34 Enter "CALIB THORIUM" for the category.
- 5.2.35 Enter "THORIUM STANDARD" for the description.
- 5.2.36 Press the "ESC" key.
- 5.2.37 Open the detector shield assembly and place the 20 gram Thorium standard in the detector well and close the detector shield assembly.
- 5.2.38 Repeat steps 5.2.19 to 5.2.30. The Th-232 standard should yield approximately 1,070,600 counts in 1,000 sec of live time counting. The counter is being calibrated against all photopeaks in the spectrum over the energy range from approximately 50 to 2,000 keV.
- 5.2.39 The computer will display "TH-232 IS DONE. PLEASE START THE RA-226 STANDARD. PRESS ANY KEY"
- 5.2.40 Press "ENTER" to continue.
- 5.2.41 Enter "YMMDDC3" for the sample ID.
- 5.2.42 Enter "CALIB RADIUM " for the category.
- 5.2.43 Enter "RADIUM STANDARD" for the description.
- 5.2.44 Press the "ESC" key.
- 5.2.45 Open the detector shield assembly and place the 20 gram Radium standard in the detector well and close the detector shield assembly.

- 5.2.46 Repeat steps 5.2.19 to 5.2.30. The Ra-226 standard should yield approximately 1,073,800 counts in 1,000 sec of live time counting. The counter is being calibrated against all photopeaks in the spectrum over the energy range from approximately 50 to 2,000 keV.
- 5.2.47 The computer will display "RA-226 IS DONE. PLEASE START THE K-40 STANDARD. PRESS ANY KEY".
- 5.2.48 Press "ENTER" to continue.
- 5.2.49 Enter "YMMDDC4" for the sample ID.
- 5.2.50 Enter "CALIB K-40" for the category.
- 5.2.51 Enter "POTASSIUM STANDARD" for the description.
- 5.2.52 Press the "ESC" key.
- 5.2.53 Open the detector shield assembly and place the 20 gram Potassium standard in the detector well and close the detector shield assembly.
- 5.2.54 Repeat steps 5.2.19 to 5.2.30. The K-40 standard should yield approximately 14,521 counts in 1,000 sec of live time counting. The counter is being calibrated against all photopeaks in the spectrum over the energy range from approximately 50 to 2,000 keV.
- 5.2.55 The computer will display "K-40 IS DONE. PLEASE START THE BACKGROUND STANDARD. PRESS ANY KEY".
- 5.2.56 Press "ENTER" to continue.
- 5.2.57 Enter "YMMDC5" for the sample ID.
- 5.2.58 Enter "CALIB BACKGROUND" for the category.
- 5.2.59 Enter "BLANK STANDARD" for the description.
- 5.2.60 Press the "ESC" key.
- 5.2.61 Open the detector shield assembly and place the 20 gram Blank standard in the detector well and close the detector shield assembly.
- 5.2.62 Repeat steps 5.2.19 to 5.2.30.
- 5.2.63 The computer will display "IS A NEW CALIBRATION DESIRED? "Y OR N".
- 5.2.64 Enter "Y" to install the calibration data into the data file.
- 5.2.65 The computer will display "CALIBRATION IS FINISHED. PRESS ANY KEY".
- 5.2.66 Press "ENTER" to continue.
- 5.2.67 Record the data and time of the calibration in the Accuspec Log Book.

5.3 Daily Background and Efficiency Checks

5.3.1 From the C:> prompt type "START" to start NUTRANL.

5.3.2 Press "ESC"

5.3.3 To Perform the Background Check:

- A) Press "A" to open the Acquire Menu.
- B) Press "P" to open the Preset Menu.
- C) Press "L" to open the Live Time Menu.
- D) Enter 3600 to set the live time to 1 hour (3600 seconds).
- E) Press "ESC" until main menu is reached.
- F) Place an empty vial in the detector assembly.
- G) Press "SHIFT-F2" to erase current spectrum.
- H) Press "F1" to start acquisition.
- I) Upon completion of acquisition press "Pg Dn" until the marker/RDI Screen is Displayed.
- J) Press "HOME" to set the curser at channel # 1.
- K) Press "CTRL-L" to set the left marker at channel # 1.
- L) Press "END" to set the cursor at channel #2045.
- M) Press "CTRL-R" to set the right marker at channel #2048.
- N) Copy the total CTS displayed onto the "Lab Instrument Check Sheet".

5.3.4 To perform the Efficiency Check:

- A) Press "A" to open the Acquire Menu.
- B) Press "P" to open the Preset Menu.
- C) Press "L" to open the Live Time Menu.
- D) Enter 60 to set the live time to 1 minute (60 seconds).
- E) Open the shield assembly and place the check source in the detector and close the shield assembly.
- F) Press "SHIFT-F2" to erase the current spectrum.
- G) Press "F1" to start acquisition.
- H) Upon Completion of Acquisition press "Pg Dn" until the markers/RDI Screen is displayed.
- I) Using the arrow keys place the curser at the left start channel of the 88 Kev Peak and press "CTRL-L" to place the left marker.
- J) Using the arrow keys place the curser at the right end channel of the 88 Kev Peak and press "CTR-R" to place the right marker.
- K) Copy the net CTS displayed onto the "Lab Instrument Check Sheet".

5.3.5 Forward the "Lab Instrument Check Sheet" for input into the computer.

5.3.6 The computer tracks the background and efficiency check using a 30 Day average and will report when either is outside of ± 2 standard deviation.

5.3.7 If the background and efficiency check meet the acceptance criteria, place the instrument in service.

5.3.8 If the efficiency check fails to meet the acceptance criteria then repeat step 5.3.4.

5.3.9 If the Accuspec fails a second efficiency check, place the instrument out of service and notify the Lab Supervisor.

5.3.10 If the data from the Blank Standard indicates a contaminated detector, place the instrument out of service and notify the Lab Supervisor.

5.4 Routine Sample Analysis

5.4.1 At the C:> prompt type "START" and press "ENTER" to start NUTRANL.

5.4.2 If the sources, U-238, Th-232, RA-226, K-40, and the blank, have been run for the day you may skip to step 5.4.54.

5.4.3 Enter " Source Count" for the category.

5.4.4 Enter "YYMMDDXX" for the identification tag where YY = year, MM = month, DD = day.

5.4.5 Enter "Radium STD" for the description.

5.4.6 Enter "20" for the weight.

5.4.7 Enter "y" for the dry weight.

5.4.8 Press "ESC" to go to the MCA Screen.

5.4.9 Press "A" to open the Acquire Menu.

5.4.10 Press "P" to open the preset menu.

5.4.11 Press "L" to open the Live Time menu.

5.4.12 Press the "300" to set live time to 5 minutes (300 seconds).

5.4.13 Press "ESC" until the main menu is displayed-

5.4.14 Open the shield assembly, insert the EPA tailing or NBL-75 standard, and close the shield assembly.

5.4.15 Press "SHIFT-F2" to erase the current spectrum.

5.4.16 Press "F1" to start Acquisition.

5.4.17 Upon completion of Acquisition press "M" to select transfer data.

5.4.18 Press "D" to select data.

5.4.19 Press "ENTER" to select the default file to move data from, the default file.

5.4.20 Enter "F" to select the destination file..

5.4.21 Enter an "ENTER" to select the default header file.

5.4.22 Press "ENTER" to select the default efficiency file.

5.4.23 Press "ESC" to return to the main menu.

5.4.24 Press "E" to exit.

5.4.25 Enter "Y" to confirm the exit.

- 5.4.26 At the "Continue with Analysis (Y or N)" prompt enter "y" to perform NUTRANL Analysis.
- 5.4.27 Upon Completion of the analysis enter "CTRL-E" to exit.
- 5.4.28 Type "PRINTOUT" and press "ENTER" to print the result.
- 5.4.29 Collect the printout and review the RA-226 result
- 5.4.30 For the USEPA tailing standard, if the value is 309.6 pCi/g to 378.4 pCi/g, ($\pm 10\%$ of 344 pCi/g) the result is acceptable. For the NBL-75 standard, if the value is 149.4 pCi/g to 182.6 pCi/g, ($\pm 10\%$ of 166 pCi/g) the result is acceptable.
- 5.4.31 Type "START" and press "ENTER" to enter NUTRANL.
- 5.4.32 If the RA-226 result was not acceptable:
- A) Press "ESC" to go to the MCA Screen.
 - B) Press "S" to open the Setup Menu.
 - C) Press "P" to open the AMP Menu.
 - D) Press "G" to open the Gain Menu.
 - E) Enter the Gain value determined from the Radium Analysis.
- NOTE: Log the "As Found" ADC an AMP Settings in the "Accu-Spec Log Book prior to adjust the gain.
- F) Press "ESC" to return to the main menu.
 - G) Repeat steps 5.4.15 to 5.4.30
 - H) Continue step 5.4.31 until RA-226 analysis is acceptable.
 - I) If unable to adjust gain to bring the RA-226 Value into the specifications of step 5.4-30 notify the lab supervisor and place the Accuspec out of service.
- 5.4.33 If the RA-226 result is acceptable enter "Thorium STD" for the Description.
- 5.4.34 Press "ESC" to go to the MCA Screen.
- 5.4.35 Open the shield assembly, place the EPA Dilute Monazite or DH-1 STD in the Detector, and close the shield assembly.
- 5.4.36 Repeat steps 5.4.15 to 5.4.28
- 5.4.37 Collect the printout and review the Th-232 result.
- 5.4.38 For the EPA Dilute Monazite standard, if the value is 135 pCi/g to 165 pCi/g, ($\pm 10\%$ of 150 pCi/g) the result is acceptable. For the DH-1 standard, if the value is 102.6 pCi/g to 125.4 pCi/g, ($\pm 10\%$ of 114 pCi/g) the result is acceptable.
- 5.4.39 Type "START" and Press "ENTER" to start NUTRANL.
- 5.4.40 If the Th-232 value was not acceptable:
- A) Repeat Steps 5.4.32 A to 5.4.31 D
 - B) Enter the gain value determined from the Th-232 analysis.
 - C) Continue at step 5.4.14
- 5.4.41 If the Th-232 Value was acceptable enter "URANIUM STD" for the description.

- 5.4.42 Press "ESC" to go to the MCA Screen.
- 5.4.43 Open the shield assembly, place the EPA Pitchblende or DH-1 STD in the detector and close the shield assembly.
- 5.4.44 Repeat steps 5.4.15 to 5.4.28.
- 5.4.45 Collect the printout and review the U-238 result
- 5.4.46 For the EPA Pitchblende standard, if the value is 2457 pCi/g to 3003 pCi/g, ($\pm 10\%$ of 2730 pCi/g) the result is acceptable. For the DH-1 standard, if the value is 529.2 pCi/g to 646.8 pCi/g, ($\pm 10\%$ of 588 pCi/g) the result is acceptable.
- 5.4.47 If the U-238 result is not acceptable:
- A) Repeat steps 5.4.31. A to 5.4.31 D
 - B) Enter the gain value determined from the U-238 analysis.
 - C) Continue at step 5.4.14
- 5.4.48 If the U-238 result is acceptable enter "Potassium STD" for the description.
- 5.4.49 Press "ESC" to go to the MCA Screen.
- 5.4.50 Open the shield assembly, place the Potassium STD in the detector, and close the shield assembly.
- 5.4.51 Repeat steps 5.4.15 to 5.4.26.
- 5.4.52 Enter "BLANK" for the description.
- 5.4.54 Press "ESC" to go to the MCA Screen.
- 5.4.55 Repeat steps 5.4.15 to 5.4.26
- 5.4.56 Enter a description to the type of sample i.e., Lot #x, off site soils, etc. for the category.
- 5.4.57 Enter a sample description i.e., Sample number.
- 5.4.58 Enter the sample weight.
- 5.4.59 Enter a "y" or "n" for dry weight.
- 5.4.60 Press "ESC" to go to the MCA Screen.
- 5.4.61 Repeat steps 5.4.9 to 5.4.11 to set count time.
- 5.4.62 Repeat steps 5.4.15 to 5.4.26.
- 5.4.63 Repeat steps 5.4.52 to 5.4.57 for each sample to be analysis.
- 5.4.64 Upon completion of sample analysis press "CTRL E" to exit.
- 5.4.65 Type "PRINTOUT" and press "ENTER" to printout a sample report.

5.4.66 Submit the data printout (see example in Attachment #1) to the Lab Supervisor and H. P. Supervisor for review.

6.0 RECORDS/REPORTS/NOTIFICATIONS

6.1 Records

6.1.1 Accuspec Log Book

6.1.2 Accuspec Sample Log Book

6.1.3 Data Printout

6.2 Reports

6.2.1 None

6.3 Notifications

6.3.1 None

6.4 Retention

6.4.1 All the records generated in performance of this procedure shall be retained for the duration of the project.

7.0 ATTACHMENTS

Attachment #1 Example - Analysis Results Printout

**ATTACHMENT #1
(Example)****GAMMA-SPEC ANALYSIS RESULTS**

Date Analyzed: 06/15/95 Time Analyzed: 1:25 Category: Source Count Analyzed by _____
Sample ID: 950615XX Description: Radium Std

Activity is reported on AS RECEIVED basis

Weight grams	U-238 pCi/g	Th-232 pCi/g	Ra-226 pCi/g	K-40 pCi/g	Total Gamma * pCi/g
20.0	2.1 ± 22.2	-0.0 ± 5.8	1740.6 ± 12.9	-66.0 ± 112.2	1676.67 ± 115.2

• Sum of U-238, Th-232, Ra-226, and K-40. Negative values are not part of total gamma.

LAKESHORE EAST

STANDARD OPERATING PROCEDURE

Title: Operation of the Ludlum Model 2000 Alpha System

Document: SOP-372

Revision Number: 0

Date: June 19, 2002

Replaces: New

OPERATION OF THE LUDLUM MODEL 2000 ALPHA SYSTEM

1.0 SCOPE

1.1 Purpose

The Ludlum Model 2000 (LM 2000) Alpha System is utilized at the control line area or in the counting laboratory for measurement of gross alpha radioactivity of various types of samples. The system normally consists of an Ludlum Model 43-10 alpha scintillation detector coupled to an Ludlum Model 2000 Scaler. This procedure describes the steps for operating the system.

1.2 Applicability

The LM 2000 system is used primarily for measuring smear samples and radon/thoron working level air samples for gross alpha radioactivity. If necessary, it may be used for the measurement of gross alpha radioactivity of air particulate and water samples in the event that the Gamma Products Model G5000 Gas Proportional Counting System is not available.

2.0 REFERENCES

- 32 Illinois Administrative Code, Parts 310 and 340, Standards for Protection Against Radiation
- 32 Illinois Administrative Code, Part 400, Notices, Instructions and Reports to Workers; Inspections
- State of Illinois Department of Nuclear Safety Radioactive Material License Number STA-583
- Ludlum Technical Manual for Ludlum Model 43-10 Alpha Sample Counter.
- Ludlum Technical Manual for Scaler Model LM 2000.

3.0 DEFINITIONS

None.

4.0 REQUIREMENTS

4.1 Prerequisites

None

4.2 Tools, Material, Equipment

- 4.2.1 Ludlum Model 43-10 Alpha Scintillation Detector
- 4.2.2 Ludlum Model LM 2000 Scaler
- 4.2.3 Appropriate calibration standard which is traceable to the National Institute of Standards and Technology (NIST):
 - a. Eberline electroplated Pu-39 standard (serial number S-4100) or equivalent

4.3 Precautions, Limits

- 4.3.1 Do not exceed 1500 volts using the H.V. ADJUST ten-turn potentiometer on the front panel of the mini scaler. Photomultiplier (PM) tube damage may result.

4.3.2 Considerable time may be lost waiting for the PM tube and crystal to dark adapt. Always keep the sample drawer in the closed position when not in use to avoid possible contamination.

4.3.3 Operate the LM 2000 only in the LINE Mode as indicated on the operating knob on the front panel. Batteries are not normally installed in the LM 2000.

4.3.4 Before counting any samples, ensure that the daily background and daily efficiency determinations have been performed.

4.3.3 Any adjustments to the high voltage, window threshold, window setting, scaler or detector change out requires a recalibration of the instrument.

4.3.4 In the event of a power failure, a background check and efficiency check is required prior to placing the instrument back in service.

4.4 Acceptance Criteria

4.4.1 The daily background determination passes if the number of counts lies between the ± 2 standard deviation range established by the background control chart.

4.4.2 The daily efficiency determination passes if the number of counts lies between the ± 2 standard deviation range established by the instrument control chart.

5.0 PROCEDURE

5.1 Initial Setup

5.1.1 Apply power to the instrument by turning the operating knob located on the front panel of the scaler to the LINE position.

5.1.2 With the sample drawer in the closed position, ensure that the high voltage is adjusted to the value determined by the most recent plateau curves. If necessary, adjust the high voltage using the H.V. ADJUST ten-turn potentiometer on the front panel of the scaler.

5.2 Plateau Curves

5.2.1 High voltage source and background plateau curves must be generated initially. If, for any reason, either the counting instrument, detector assembly or PM tube is changed, a set of new curves must be run.

5.2.2 On a VOLTAGE PLATEAU form (Attachment 2), record the instrument, observer, date, time, source serial number, and any other pertinent information.

5.2.3 Turn the high voltage to a minimum using the H.V. ADJUST ten-turn potentiometer on the front panel of the scaler.

5.2.4 Apply power to the instrument by turning the power knob located on the front panel of the scaler to the LINE position.

5.2.5 Set an appropriate count time (1 minute suggested) using the timer adjustment switches on the front panel of the scaler.

5.2.6 Place the Pu-239 check source in the sample tray and close the tray, locking it closed with the unlocking knob.

- 5.2.7 Adjust the ten-turn potentiometer in definitive increments (50 volts suggested), recording the counts and voltage on the "VOLTAGE PLATEAU" form.

NOTE:

Do not exceed 1500 volts. If 1500 volts are exceeded the photomultiplier tube may be damaged. If using the RD-14, do not exceed 1800 volts.

- 5.2.8 Plot the reading versus high voltage settings on a sheet of rectangular coordinate paper.
- 5.2.9 Remove the check source from the detector and close the sample drawer.
- 5.2.10 Repeat steps 5.2.7 and 5.2.8 without the source, for a background
- 5.2.11 Plot the results of the high voltage background plateau curve on the same plot as the high voltage source plateau curve.
- 5.2.12 From the graph, choose the high voltage setting which is on the flat portion of the curve with a minimum background count. Set the high voltage to this value.

5.3 Chi-square Test

- 5.3.1 A Chi-square test must be generated upon initial setup, equipment change out or repair, high voltage adjustment, and monthly.
- 5.3.2 Obtain the "COUNTER TEST-CHI-SQUARED" data sheet (Attachment 1).
- 5.3.3 Record:
- a. Your name
 - b. The date
 - c. Time
 - d. The high voltage setting
 - e. The source used
- 5.3.4 Open the sample tray, place the Pu-239 source into the planchet, and close the sample tray.
- 5.3.5 Set the timer for 1 minute and depress the count button.
- 5.3.6 Upon completion of the count, record the results on the "COUNTER TEST-CHI-SQUARED DATA SHEET," Attachment 1.
- 5.3.7 Repeat steps 5.3.5 to 5.3.6 until 21 data points have been recorded. Remove the source from the detector. Record this data on Attachment 1.
- 5.3.8 When all the above data has been entered on Attachment 1, perform the calculations on Attachment 1.
- 5.3.9 Using the table on Attachment 1, find the value of "P" and record the value on Attachment 1. If the value of "P" falls between 0.98 and 0.10, the counter passes the test. If the value of "P" falls outside of these values, the counter fails the test.
- 5.3.10 If the counter fails the test, rerun the test. If the counter fails a second time, tag the detector out of service and notify the lab supervisor.

5.4 Background Determination

5.4.1 Perform a 50 minute instrument background check daily.

- a. Verify that the LM 2000 is not in a count sequence by insuring that the "count" light is not lit.
- b. Open the sample tray by operating the unlocking knob and sliding the tray out of the detector.

NOTE

The 43-10 is a scintillation detector and is light sensitive. Care must be used not to force or pull sideways when opening the sample tray.

- c. Remove any sample that may have been left in the detector and clean the sample tray with a clean cloth.
- d. Insert the Pu-239 alpha standard and shut the sample tray by gently sliding the tray into the detector and operating the unlocking knob.
- e. Press the count button and verify that the count light is on indicating that the LM 2000 is in a counting sequence.
- f. Counting is complete when the count light is extinguished.

5.4.2 Record the results of the background measurement onto the LM 2000 log and the daily LAB INSTRUMENT CHECK SHEET.

5.4.3 If the 2 sigma error from the daily background does not overlap the 2 sigma error of the previous 30 days background, then the sample tray should be decontaminated and the background should be recounted.

5.5 Efficiency Determination

5.5.1 Following the background measurement, perform an efficiency determination with the Pu-239 alpha standard designated for this purpose using a count time of 5 minutes. The efficiency determination must be performed daily, or if not used daily, prior to each use.

- a. Verify that the LM 2000 is not in a count sequence by insuring that the "count" light is not lit.
- b. Open the sample tray by operating the unlocking knob and sliding the tray out of the detector.

NOTE

The 43-10 is a scintillation detector and is light sensitive. Care must be used not to force or pull sideways when opening the sample tray.

- c. Remove any sample that may have been left in the detector.
- d. Shut the sample tray by gently sliding the tray into the detector and operating the unlocking knob.

- e. Press the count button and verify that the count light is on, indicating that the LM 2000 is in a count sequence.
 - f. Counting is complete when the count light is extinguished.
- 5.5.2 Log the results of the efficiency determination onto the daily LAB INSTRUMENT CHECK SHEET:
- 5.5.3 The daily efficiency determination is acceptable if the number of counts lies between the ± 2 stand deviation range established by the instrument control chart.
- 5.5.4 If the instrument fails the daily efficiency determination the first time, it must subsequently pass two consecutive times before the instrument is considered acceptable for operation.
- 5.5.5 If the daily efficiency fails two consecutive times, the instrument is placed out of operation until the cause of the failures is investigated. The system is placed back into operation only after:
 - a. The cause of the failures has been identified and recorded in the instrument log.
 - b. Efficiencies have been verified or system recalibration has taken place.
- 5.6 Lower Limit of Detection (LLD) Determination
 - 5.6.1 Use the equation shown on Attachment 3, the Smear Counting Data sheet, to determine the LLD.
 - 5.6.2 Record the LLD on each SMEAR COUNTING DATA SHEET, or printout when available.
- 5.7 Routine Sample Analysis
 - 5.7.1 Set the desired count time using the timer adjustment switches on the front panel of the mini scaler.
 - 5.7.2 Using forceps, remove the smear or air particulate sample to be counted from the glassine envelope and load it into a sample planchet. For evaporated samples (i.e., liquids) proceed to the next step.
 - 5.7.3 Open the sample drawer.
 - 5.7.4 Position the sample planchet in the center of the sample drawer.
 - 5.7.5 Slide the sample drawer to the fully closed position and lock closed by operating the unlocking knob.
 - 5.7.6 Start the count by pressing the COUNT button on the front panel of the scaler.
 - 5.7.7 At the conclusion of the count, open the sample drawer, remove the sample planchet, and return the sample drawer to the closed position.
 - 5.7.8 Remove the sample from the planchet, return it to the glassine envelope, and store the sample in the designated location.
 - 5.7.9 Attach the printout, if available, to the survey, recording the survey number, instrument background, efficiency, and lower limit of detection on the printout. If no printout is

available, record the counts accumulated on the scaler onto the **SMEAR COUNTING DATA SHEET** (Attachment 3).

5.8 INSTRUMENT OUT OF CALIBRATION

- 5.8.1 When an instrument is found to be "out of calibration" or fails a daily response check immediately notify the HP Supervisor.
- 5.8.2 The HP Supervisor shall determine the last date that the instrument passed a daily source response check, or the last calibration date, whichever is later.
- 5.8.3 Based on the last acceptable source response check or good calibration date, the HP Supervisor shall determine what radiological surveys were performed with the defective instrument.
- 5.8.4 The HP Supervisor shall determine whether regulatory or general information surveys were performed with the defective instrument.
- 5.8.5 Using previous surveys or previous knowledge of the survey data, the HP Supervisor shall determine whether the surveys taken with the defective meter are acceptable or the surveys must be re-performed. In the case of regulatory surveys the survey shall be retaken, if possible, if resurveying is not possible the HP Supervisor will make a written assessment of the quality of the data.
- 5.8.6 Source check failures/ "out of calibration" are to be recorded in the instrument log book and a nonconformance report (NCR) shall be initiated per QPM-DOC #9, in order to assess trends.

6.0 RECORDS/REPORTS/NOTIFICATIONS

6.1 Lab Instrument Check Sheet

- 6.1.1 The **LAB INSTRUMENT CHECK SHEET** is utilized to record the results of the daily background measurement and daily efficiency determination. The information from the sheet is entered into the Health Physics database.

6.2 Voltage Plateau Form

- 6.2.1 The **VOLTAGE PLATEAU** form is utilized to record the data used to generate the high voltage and background plateau curves.

6.3 Smear Counting Data Sheet

- 6.3.1 The Smear Counting Data sheet is utilized to record all pertinent data from smear counting where no printing device is available.

7.0 ATTACHMENTS

- 7.1 Attachment 1 Counter Test-Chi Squared
- 7.2 Attachment 2 Voltage Plateau Form
- 7.3 Attachment 3 Smear Counting Data Sheet

ATTACHMENT 1

COUNTER TEST - CHI-SQUARED (χ^2)

OBSERVER	DATE	TIME	VOLTAGE SETTING	STANDARD
COUNT TIME - ONE MINUTE				
COUNT	NET COUNT	AVERAGE		
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
TOTAL OF 20			TOTAL	

P	χ^2
0.98	8.5
0.95	10.1
0.90	11.6
0.80	13.7
0.50	18.4
0.20	23.8
0.10	27.3

IF P FALLS BETWEEN 0.98 AND 0.10 THE COUNTER IS FUNCTIONING PROPERLY

* Discard one unusually high or low count in calculating \bar{n} .

$$\bar{n} = \frac{\sum n}{20} = \boxed{} \quad \text{Enter this value in } n \text{ column for each count number.}$$

$$\chi^2 = \frac{\sum (n - \bar{n})^2}{\bar{n}} = \boxed{} \quad P = \boxed{}$$

$$\text{Standard Deviation for a 95\% Confidence Level} = (1.96) \left(\sqrt{\frac{\sum (n - \bar{n})^2}{20}} \right)$$

**ATTACHMENT 2
VOLTAGE PLATEAU FORM
RD-14/LM-2000**

Instrument Serial Number _____ Source Serial Number _____ Date _____
Pulser Serial Number _____ Scaler Model Number _____ Serial Number _____
Technician Name _____ Technician Signature _____

Counts per Minute

4500												
4000												
3500												
3000												
2500												
2000												
1500												
1000												
500												
0												
	700	800	900	1000	1100	1250	1300	1400	1500	1600	1700	1800

DETECTOR VOLTAGE

